

STAR ICVS Annual Review OMPS Instrument and Product Demonstration Sites

L.E. Flynn

from compilations by D. Liang and E. Beach

with special acknowledgements to M. Grotenhuis and W. Yu

and further acknowledgements to the OMPS SDR and Product Teams

May 8, 2015

Instrument Monitoring Outline

- **Instrument overview**
- **STAR OMPS-LTM overview**
- **NM/NP sensor anomalies**
- **Solar eclipse event**
- **OMPS NM/NP “Chasing Orbit” comparisons with NOAA-19 SBUV/2**

Nadir Mapper & Profiler

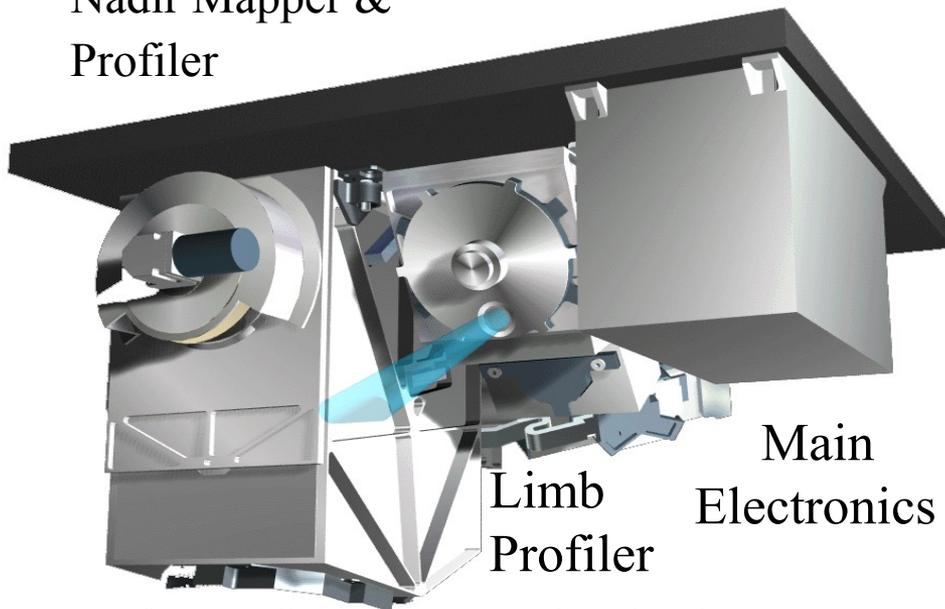
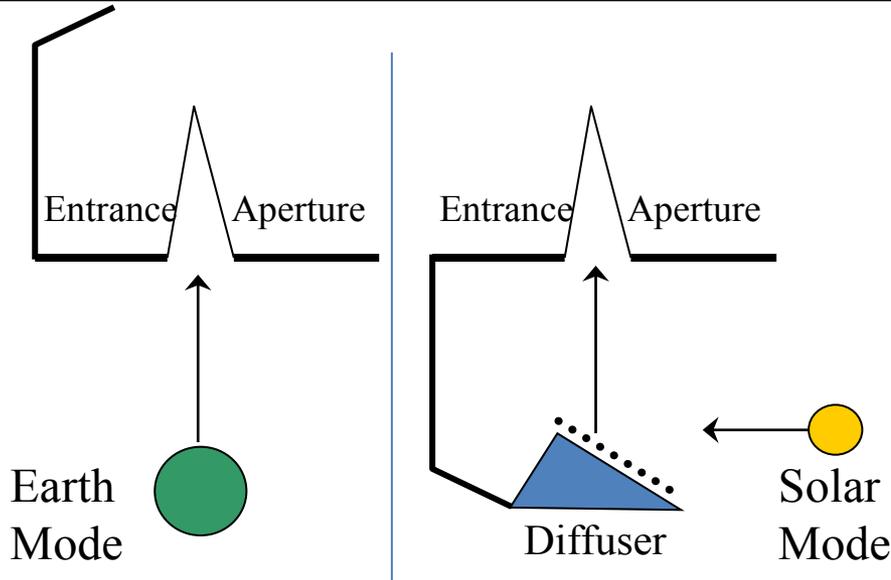


Diagram from Ball Aerospace and Technology Corporation

The instruments measure radiance scattered from the Earth's atmosphere and surface. The detectors are 2-D CCD arrays with one spectral and one spatial dimension.

They also make solar measurements using pairs of diffusers. Judicious operation of working and reference diffusers allows analysts to track the diffuser degradation. The solar measurements also provide checks on the wavelength scale and bandpass. The instruments regularly conduct their internal dark and nonlinearity calibration sequences and have completed a full three years of solar measurements.

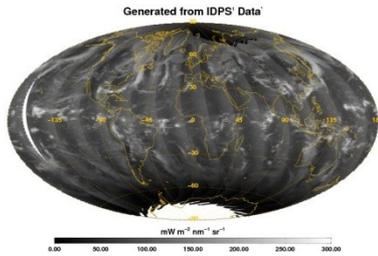


Each instrument can view the Earth or either of two solar diffusers; a working and a reference.

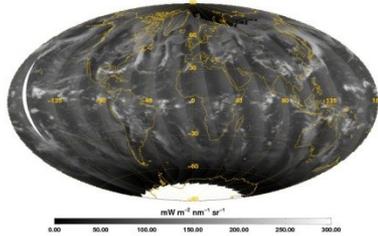
NPP/OMPS ICVS Monitoring

- We continue to regularly monitor the OMPS radiance maps, performance parameters, and telemetry:

Suomi-NPP OMPS Total Column Radiance at 331 nm, 2015/04/21



Generated from PEATE' Data



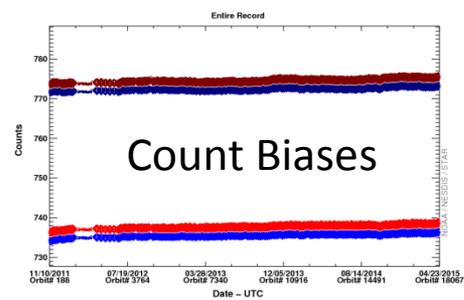
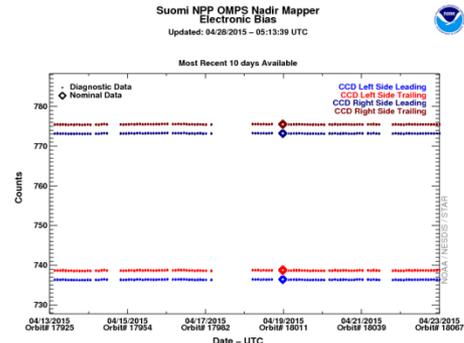
1. Generated by the NPP Interface Data Processing Segment (IDPS)
 2. Generated by the NPP Product Evaluation and Analysis Tools Segment (PEATE)
 *Note that differences in PEATE and IDPS data definitions may result in different geographical coverages

Daily Maps of
Radiances



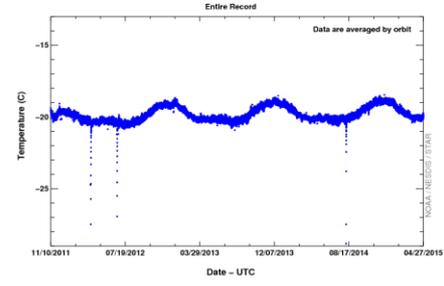
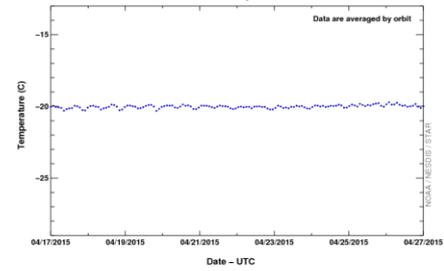
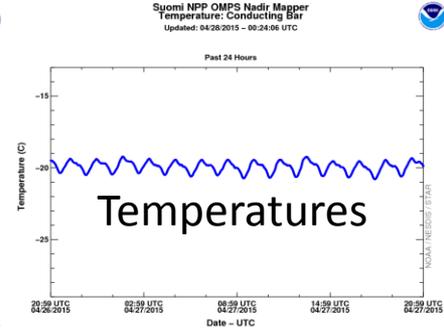
NOAA NESDIS STAR

NOAA NESDIS STAR



NOAA NESDIS STAR

NOAA NESDIS STAR

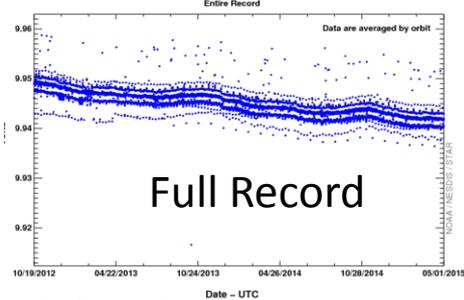
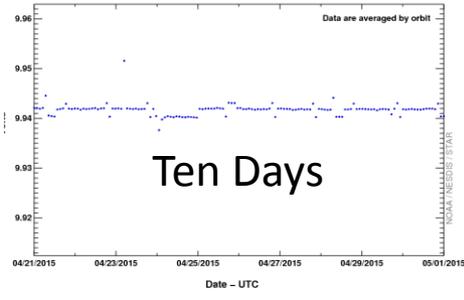
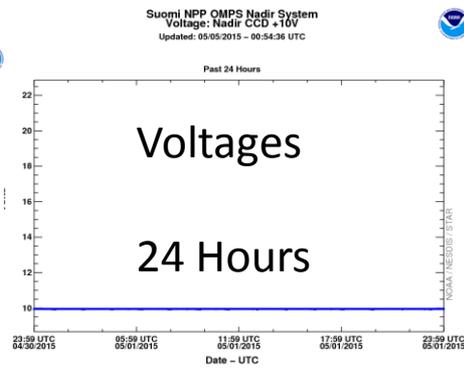


NOAA NESDIS STAR

NOAA NESDIS STAR

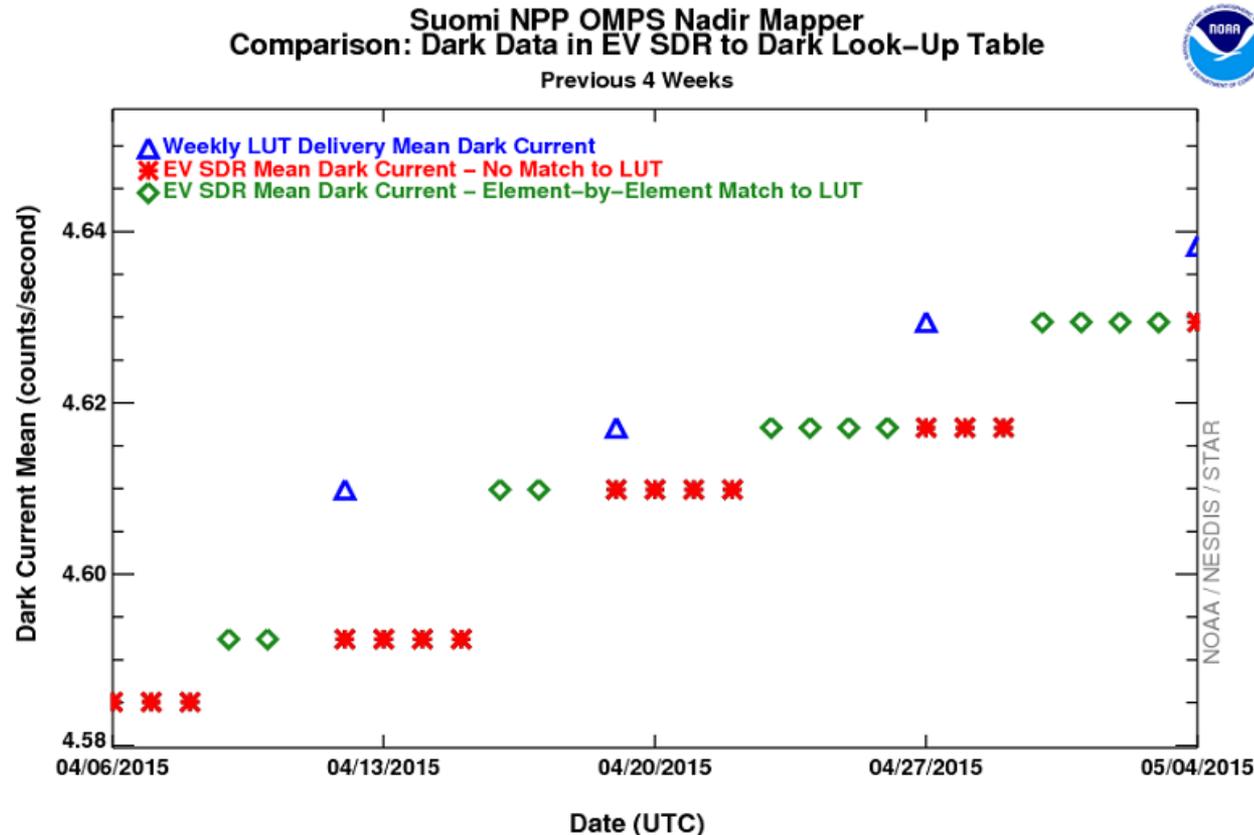
NOAA NESDIS STAR

NOAA NESDIS STAR



- Automated anomaly detection and email warnings are established for the NM EV radiance and NM and NP performance

OMPS Nadir Mapper/Nadir Profiler Dark Current LUT Updates



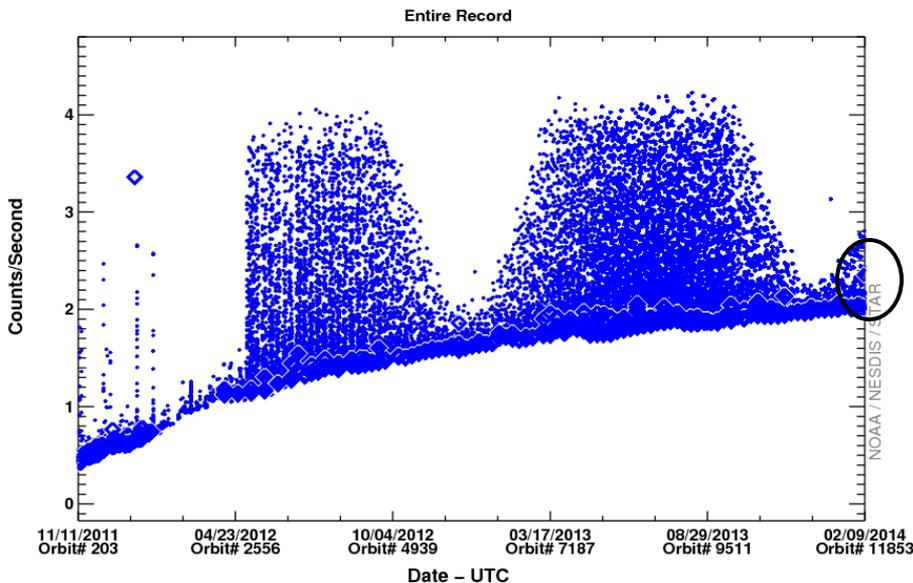
Nadir Mapper (NM)/Nadir Profiler (NP) Dark Current LUT Plots Show:

- Timely weekly updates of the dark current Look-Up Table (LUT) for calibration (blue triangles)
- Implementation of the weekly dark LUT (transition from red to green) into the Earth View Sensor Data Record (SDR)
- Expected steady increase of the dark current (y-axis)

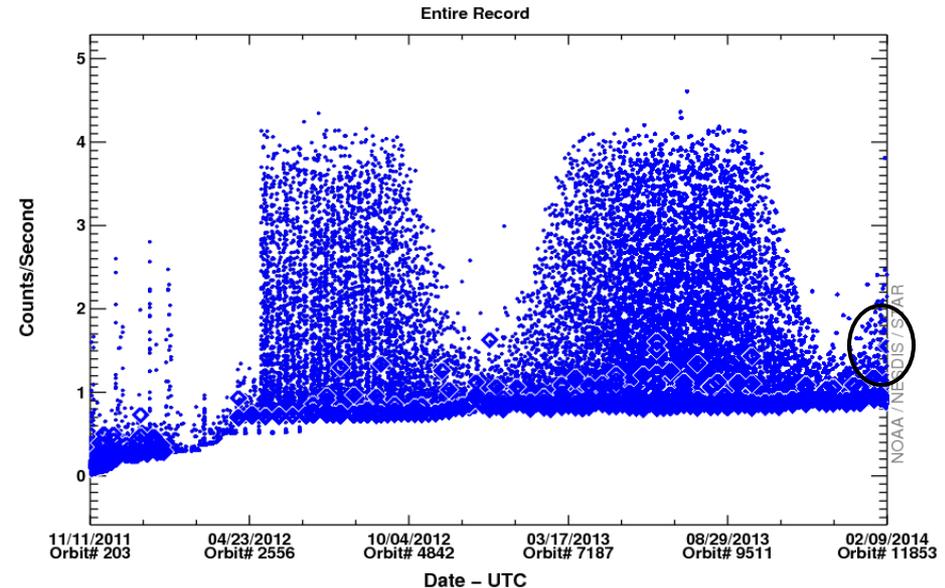
NPP/OMPS Sensor/Data Status

- The OMPS calibration monitoring system detected anomalies in the NM and NP standard deviation of dark current from dark calibration images acquired on Feb. 9, 2014

Suomi NPP OMPS Nadir Mapper
Dark Current Standard Deviation
Updated: 02/14/2014 - 03:03:45 UTC

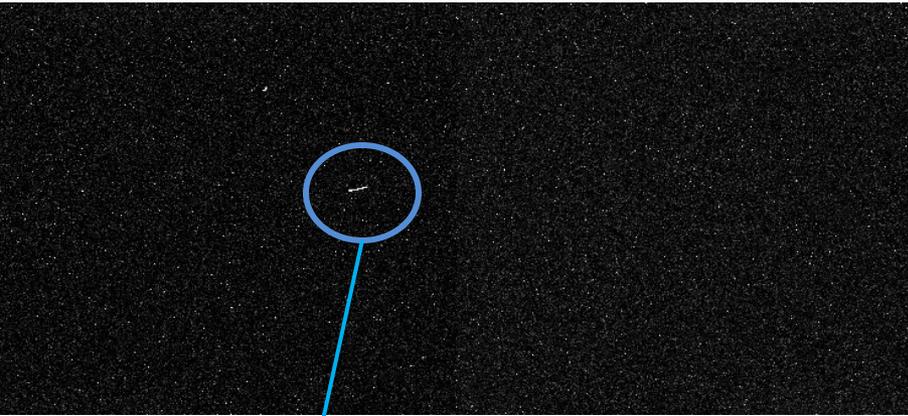


Suomi NPP OMPS Nadir Profiler
Dark Current Standard Deviation
Updated: 02/14/2014 - 04:47:11 UTC

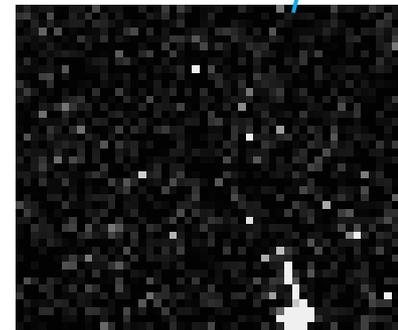
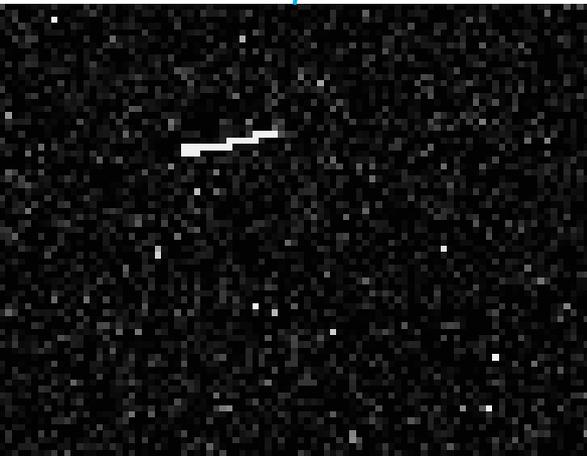


NM/NP Anomalous Dark Calibration Images

NM Anomalous Calibration Image



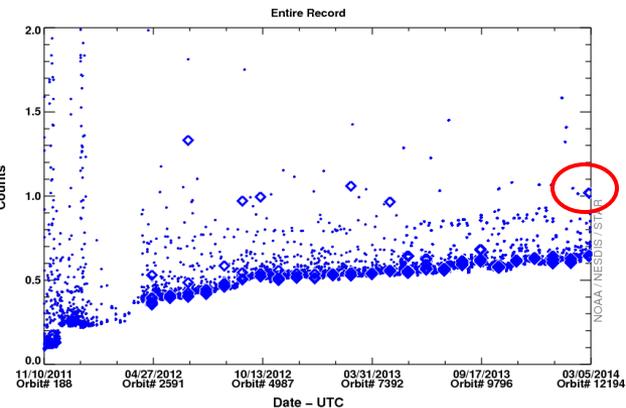
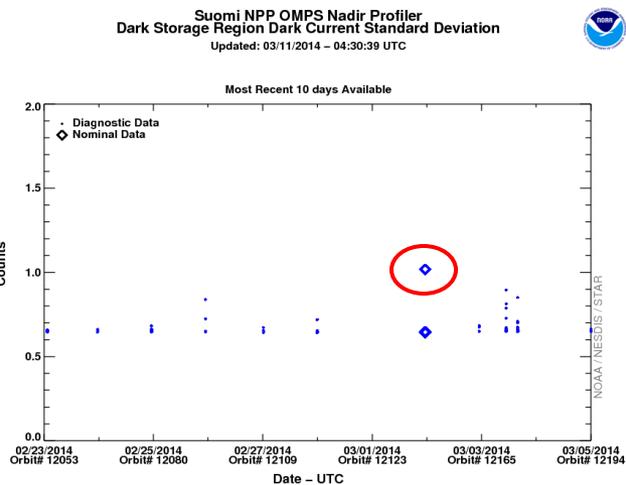
NP Anomalous Calibration Image



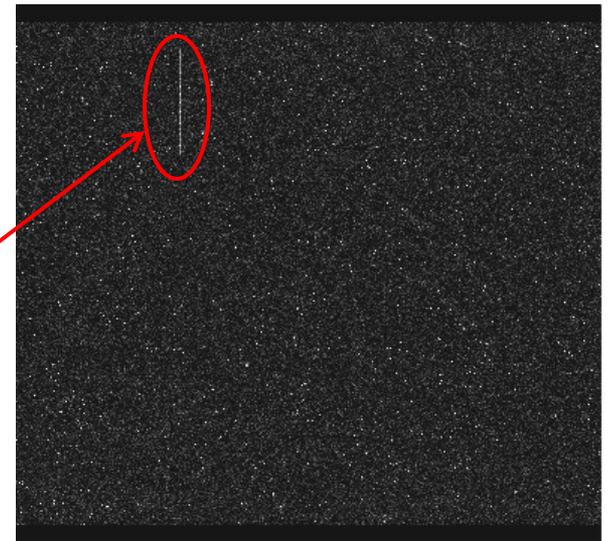
Particles from solar activity?
Cosmic rays?

NPP/OMPS Sensor/Data Status

- Anomaly detected, email warning automatically sent: NP Dark Current Stddev/Average on March 2, 2014



An examination of the corresponding NP storage region dark calibration image revealed the cause:



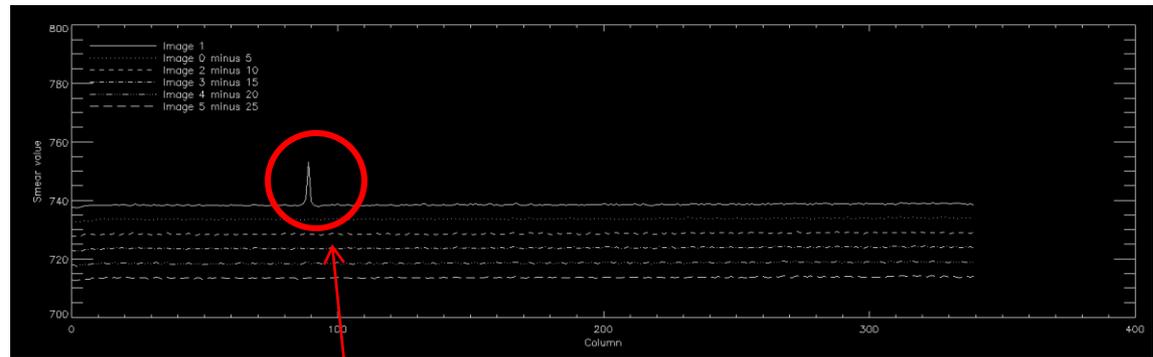
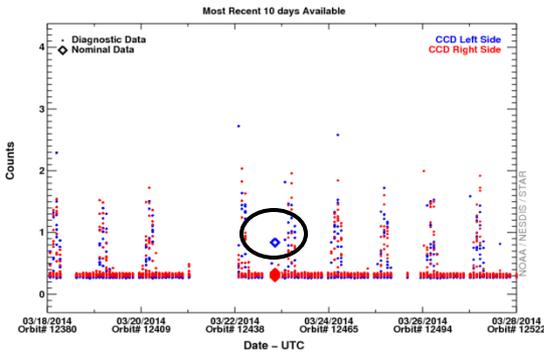
Why is this perfectly vertical?

The PEATE dark calibration is designed to handle transients like these, so there will be no impact on data quality.

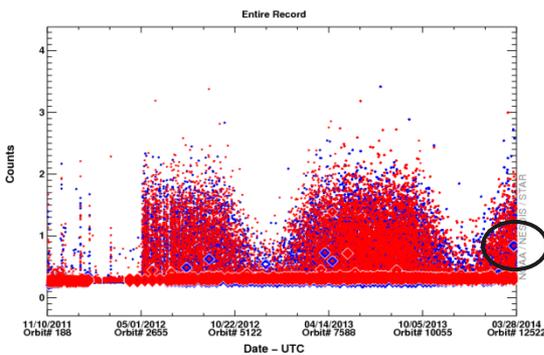
NPP/OMPS Sensor/Data Status

Anomaly detected, email warning automatically sent: NM CCD1 smear values standard deviation on March 23rd, 2014. The smear is a calibration parameter that estimates the signal that is accumulated during the CCD charge transfer to the storage (readout) region.

Suomi NPP OMPS Nadir Mapper
Dark Smear Counts Standard Deviation
Updated: 04/03/2014 - 02:41:25 UTC



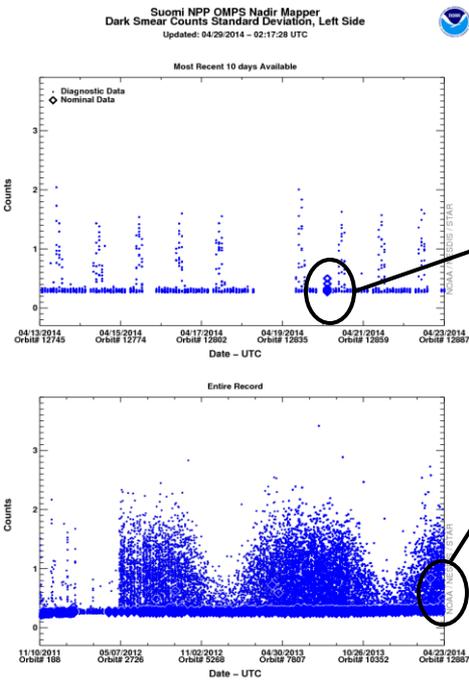
The average smear value for one column of one dark calibration image was anomalously high



The PEATE Cal SDR team was notified. Anomaly is due to a transient spike in the smear signal. These occurrences are supposed to be detected and repaired, but there is a flaw in the algorithm. The flaw was previously noticed and is being fixed.

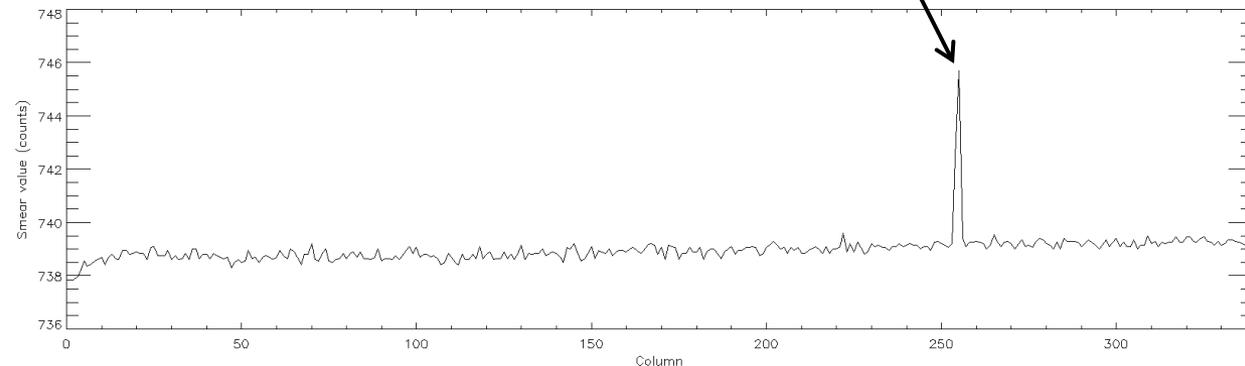
NM Cal SDR Anomaly: Transient in Smear

NM Anomaly in PEATE Calibration SDR data on April 20th, 2014: “spike” for one column of CCD1 smear signal in calibration dark image



High standard deviation for the smears corresponding to the image with the transient

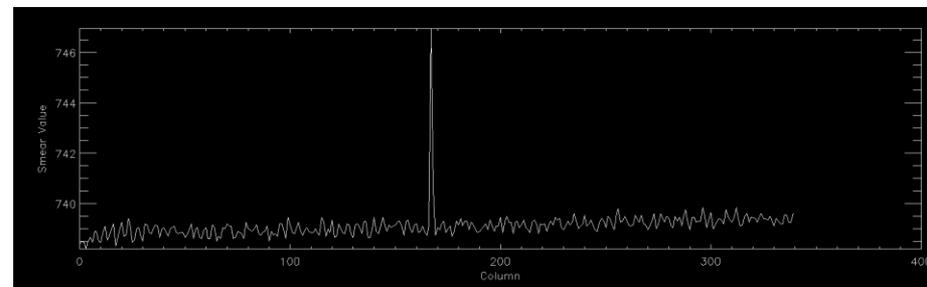
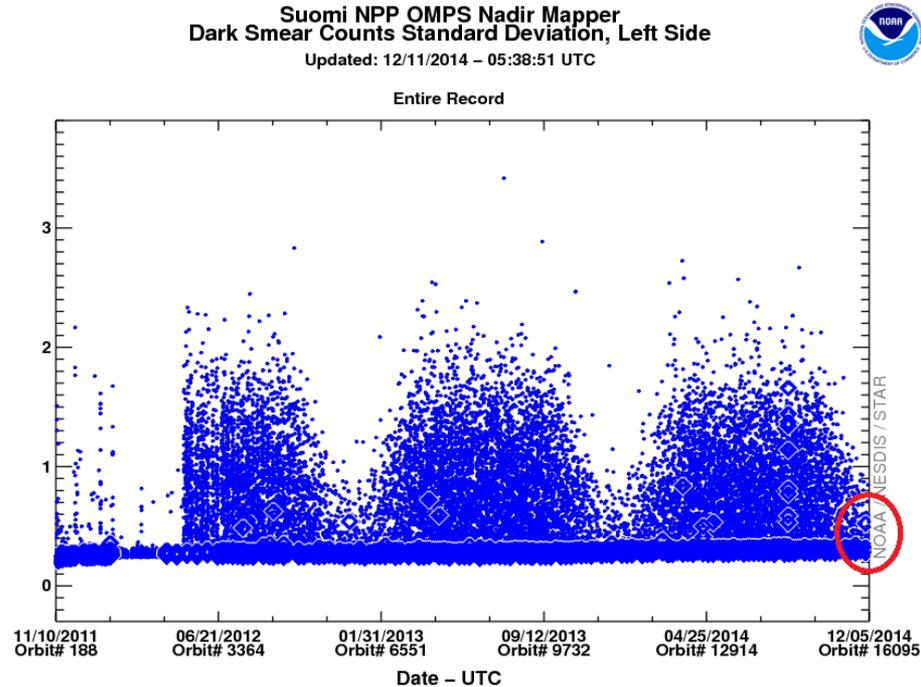
Transient found in two columns of 35th NM nominal dark image from April 20th



PEATE Calibration Team response: previous statement that smear transients do not affect Earthview (EV) data is incorrect: they do affect the data. However, the effect is small: this transient caused 0.13% and 0.07% error in dark current rates, which amounts to 0.39 and 0.21 EV count (out of ~230,000). The PEATE team is working to fix the necessary filters.

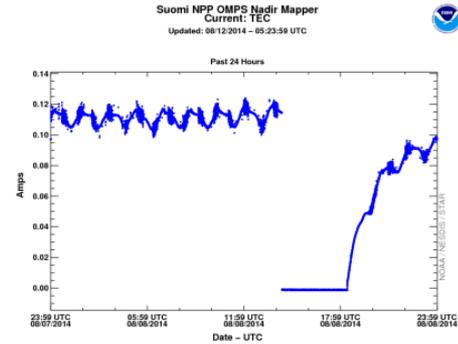
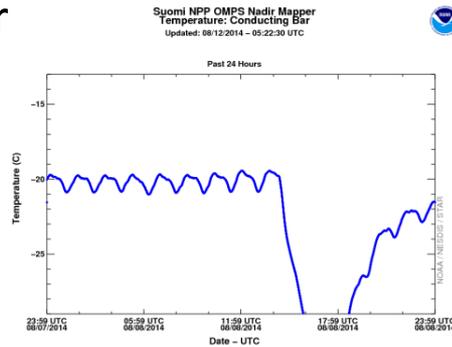
OMPS NM Anomaly in Dark Current Calibration, 11/30/2014

- An anomaly in the OMPS NM Dark Current calibration on November 30th, 2014 was automatically detected
- There was a transient in the smear signal during the calibration for dark current
- The anomaly has minimal impact on calibrated radiance, ~1 count. The smear signal is used to calculate the CCD electronic bias, but the transient affects only a small portion of the smear, and is not significantly above the baseline signal.
- Software for smear transient detection and correction has been created by the PEATE team, and they are in the process of implementing into the L1B code

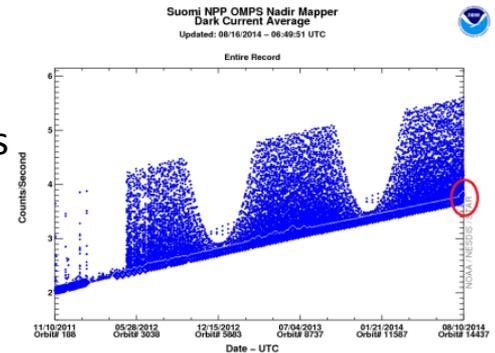


OMPS Anomalies/Warnings

- Aug 8, 2014: Many temperatures/voltages/currents exhibited atypical behavior during/after S-NPP drag maneuver



- Aug 10, 2014: NM/NP Dark Current Increase
 - Believed to be due to Aug 8 anomaly, however temps/voltages/currents were back to normal levels by Aug 10
 - May be a permanent change in dark current/hot pixels – values have not returned to pre-Aug 10th levels, though they have relaxed somewhat
 - The exact cause is unknown, and PEATE team is still investigating

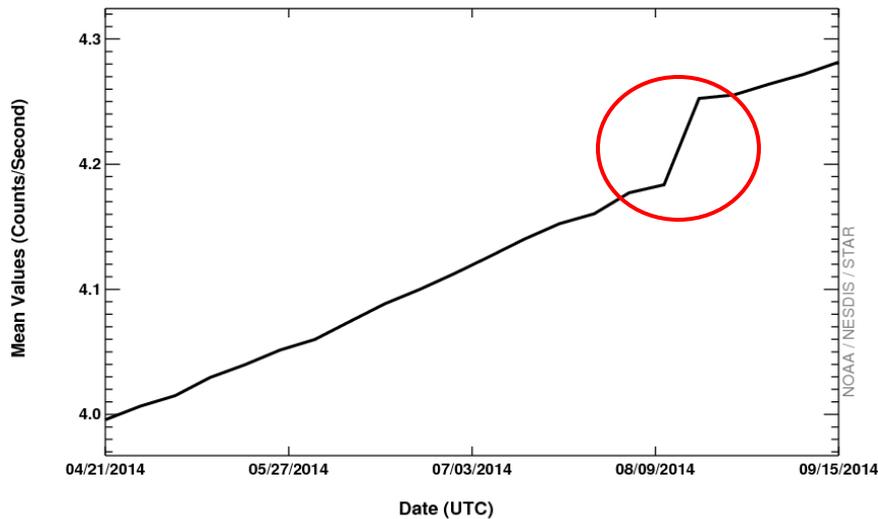


- Aug 16, 2014: Many sensor performance parameters were anomalous. Nominal Cal SDR data were accidentally acquired while spacecraft was in SAA

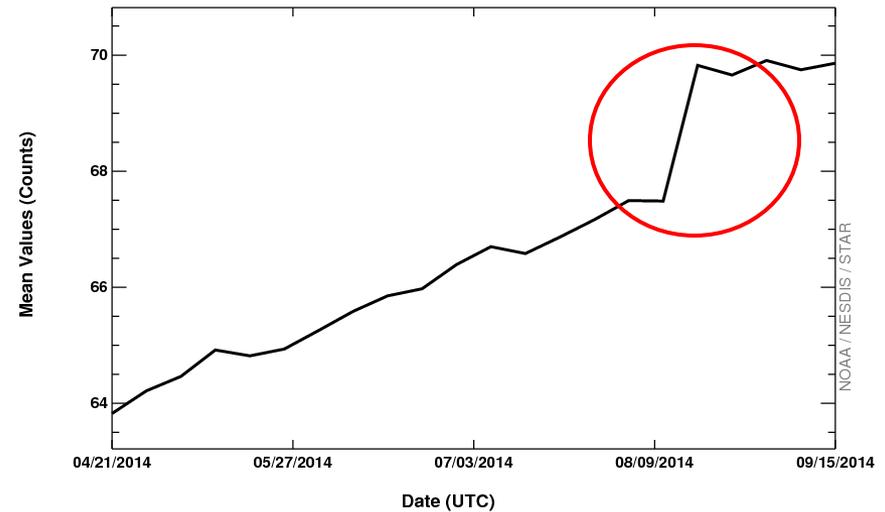
OMPS Anomalies/Warnings

- Dark current increases that occurred on Aug 10, 2014 were permanent

Suomi NPP OMPS Nadir Mapper
Statistics: Dark Current in Dark Look-Up Table
Mean Values, Entire Record



Suomi NPP OMPS Nadir Profiler
Statistics: Counts in Dark Look-Up Table
Mean Values, Entire Record



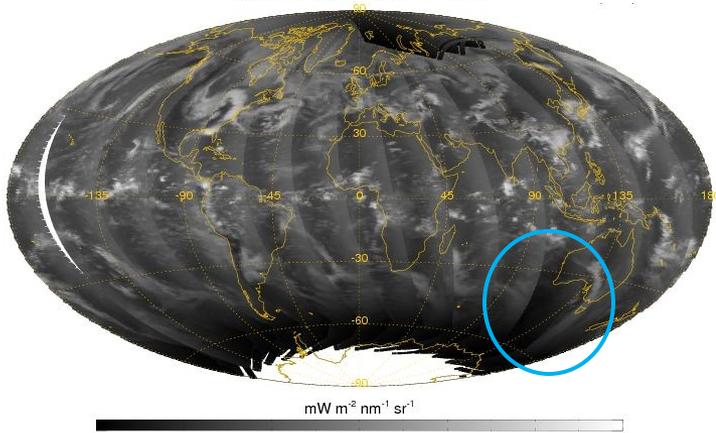
- Believed to be due to August 8th, 2014 maneuver, but exact cause is still unknown

Solar Eclipse: Apr 29th, 2014

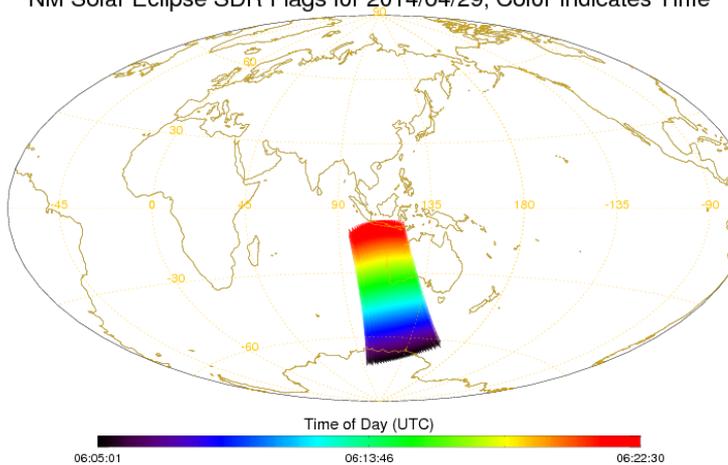
Suomi-NPP OMPS Total Column Radiance at 331 nm, 2014/04/29



Generated from IDPS' Data'



NM Solar Eclipse SDR Flags for 2014/04/29, Color Indicates Time

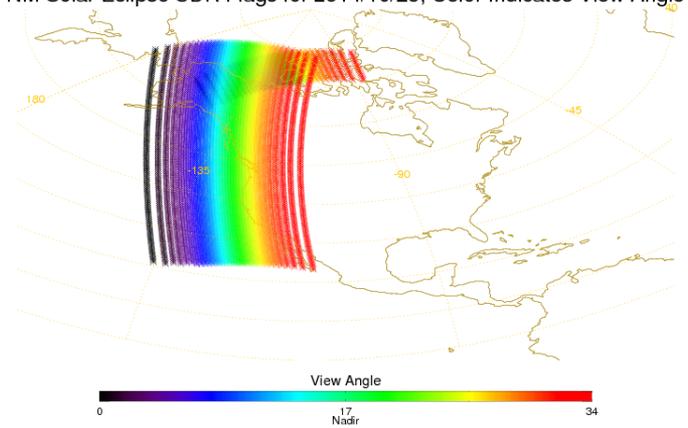


OMPS Solar Eclipse quality flag indicated a solar eclipse on April 29th, affecting OMPS data from 06:05:01 to 06:22:30 UTC.

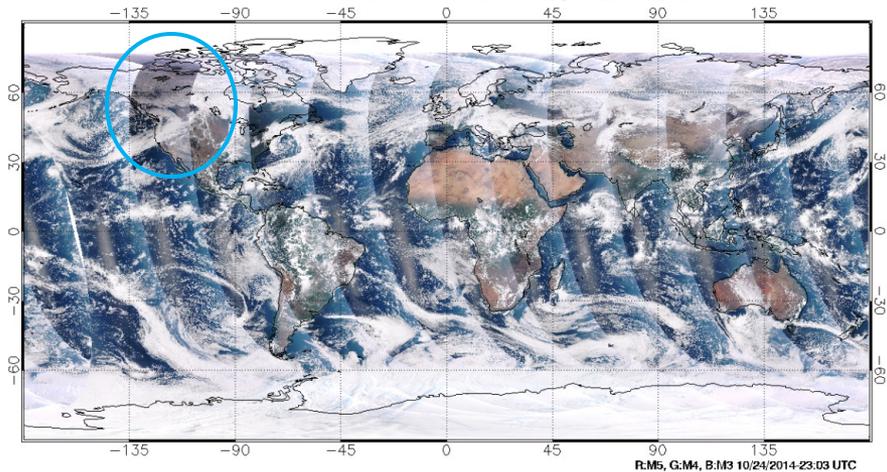
A warning email was sent to the STAR Suomi-NPP Cal/Val Team leads.

Solar Eclipse: Oct 23rd, 2014

NM Solar Eclipse SDR Flags for 2014/10/23, Color Indicates View Angle



Suomi NPP VIIRS Global True Color Image 2014-10-23



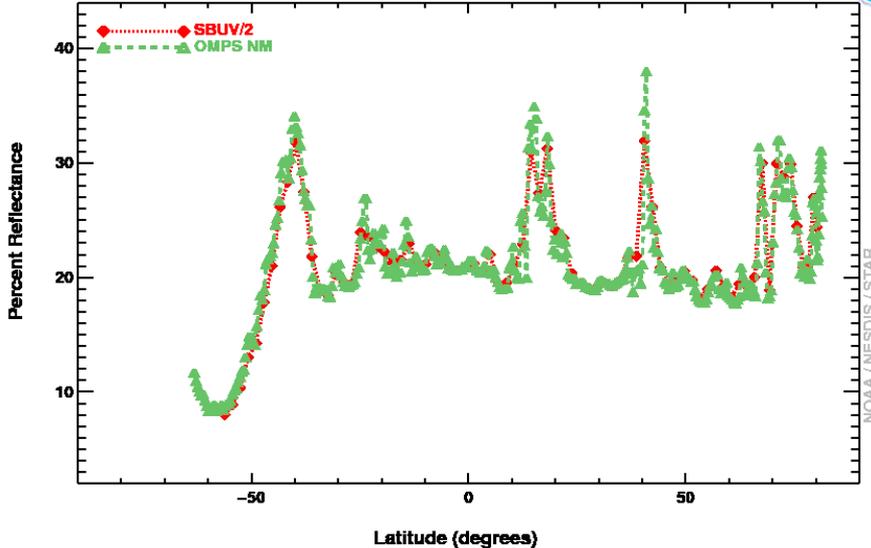
OMPS Solar Eclipse quality flag indicated a solar eclipse on Oct. 23rd, affecting OMPS data from 20:01:12, 21:44:49 UTC.

A warning email was sent to the STAR Suomi-NPP Cal/Val Team leads.

OMPS Nadir Mapper/Nadir Profiler “Chasing Orbit” Comparisons with NOAA-19 SBUV/2

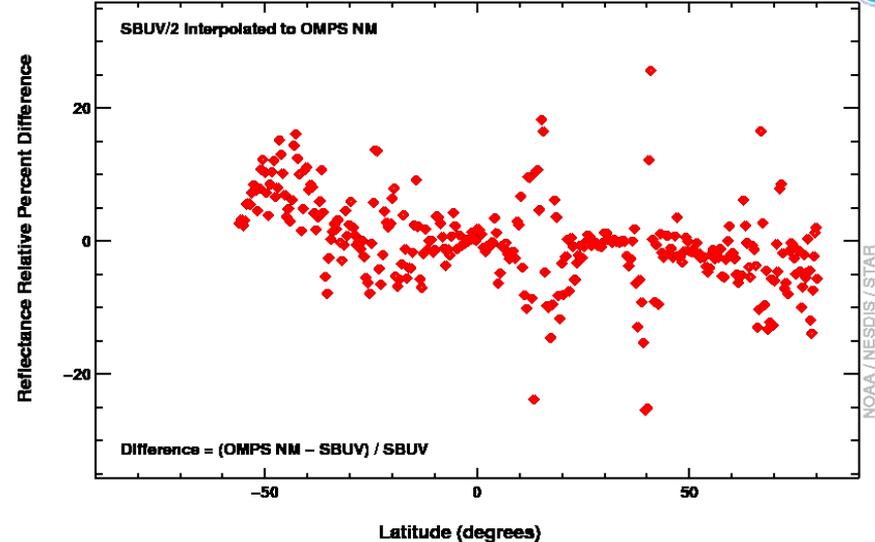
Approximately every 12 days, the NOAA-19 and Suomi-NPP orbits align temporally and spatially, and the data from the Solar Backscatter Ultraviolet Instrument (SBUV/2) onboard NOAA-19 and the OMPS NM/NP onboard Suomi-NPP can be directly compared. Plots for every “Chasing Orbit” and SBUV/2 channel are available on the ICVS.

Chasing Orbit Comparison, Wavelength 318 nm, 2014/07/27, 10:21 UTC
Difference in longitude at equator crossing: 0.03 degrees, Time difference: 20.5 minutes



OMPS NM reflectance (green) and SBUV/2 Reflectance (red) vs. latitude for a “Chasing Orbit” on July 27, 2014

Chasing Orbit Comparison, Wavelength 313 nm, 2014/07/27, 10:21 UTC
Difference in longitude at equator crossing: 0.03 degrees, Time difference: 20.5 minutes



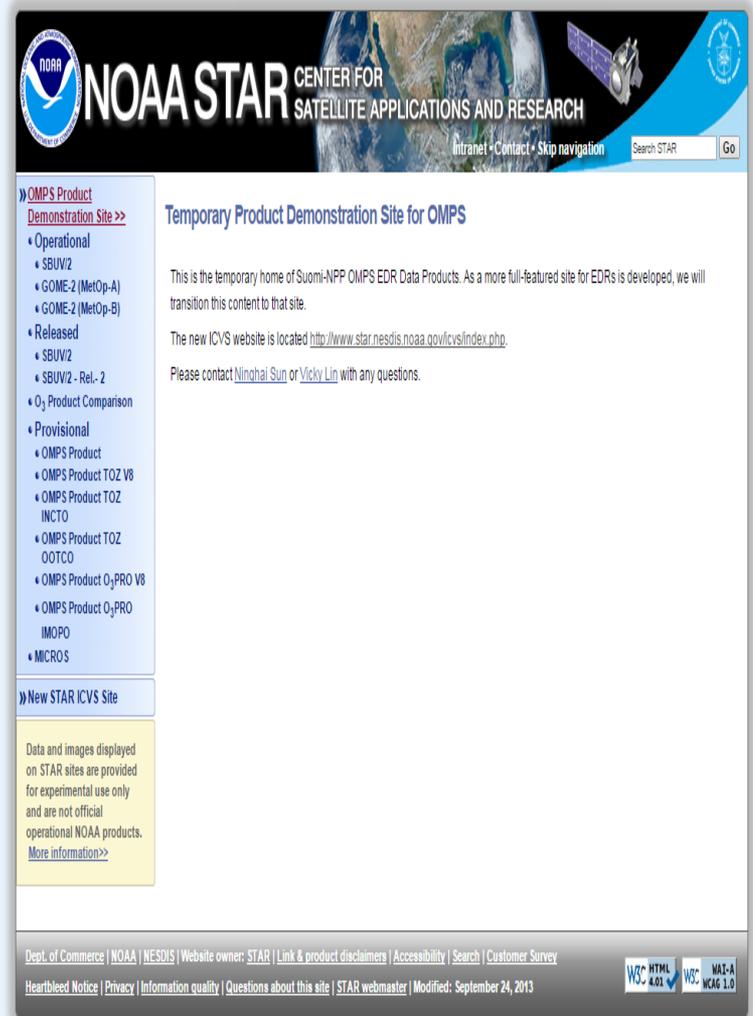
Relative difference in reflectance vs. latitude for a “Chasing Orbit” on July 27, 2014

OMPS Product Demo Site URL:

<http://www.star.nesdis.noaa.gov/icvs/prodDemos/index.php>

General Characteristics of site:

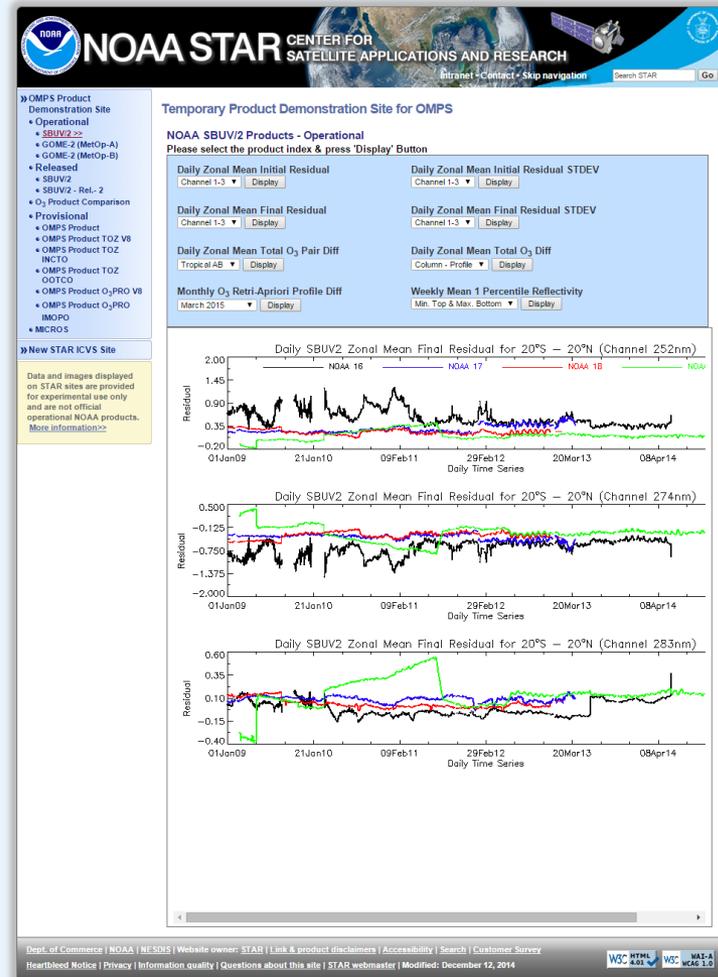
- Depicts performance of OMPS, GOME-2 and SBUV/2 instruments
- Updated daily, weekly, or monthly depending upon the type of plot
- Navigable via menu on left side of page. Pull down menus are available for most plot types to select previous time periods.
- Site is still under construction



The screenshot shows the NOAA STAR website interface. At the top, there is a header with the NOAA logo and the text "NOAA STAR CENTER FOR SATELLITE APPLICATIONS AND RESEARCH". Below the header, there is a navigation bar with links for "Intranet", "Contact", and "Skip navigation", along with a search bar labeled "Search STAR" and a "Go" button. The main content area is divided into two columns. The left column contains a menu with the following items: "OMPS Product Demonstration Site >>", "Operational" (with sub-items: "SBUV2", "GOME-2 (MetOp-A)", "GOME-2 (MetOp-B)"), "Released" (with sub-items: "SBUV2", "SBUV2 - Rel- 2", "O₃ Product Comparison"), "Provisional" (with sub-items: "OMPS Product", "OMPS Product TOZ V8", "OMPS Product TOZ INCTO", "OMPS Product TOZ OOTCO", "OMPS Product O₃-PRO V8", "OMPS Product O₃-PRO IMOPO", "MICROS"), "New STAR ICVS Site", and a disclaimer box stating "Data and images displayed on STAR sites are provided for experimental use only and are not official operational NOAA products. More information>>". The right column features the heading "Temporary Product Demonstration Site for OMPS" and two paragraphs of text: "This is the temporary home of Suomi-NPP OMPS EDR Data Products. As a more full-featured site for EDRs is developed, we will transition this content to that site." and "The new ICVS website is located <http://www.star.nesdis.noaa.gov/icvs/index.php>. Please contact [Ninghai Sun](#) or [Vicky Lin](#) with any questions." The footer contains a row of links: "Dept. of Commerce | NOAA | NESDIS | Website owner: STAR | Link & product disclaimers | Accessibility | Search | Customer Survey", a row of links: "Heartbleed Notice | Privacy | Information quality | Questions about this site | STAR webmaster | Modified: September 24, 2013", and a row of logos: "W3C HTML 4.01", "W3C WAI-A WCAG 1.0".

SBUV/2 Operational Performance

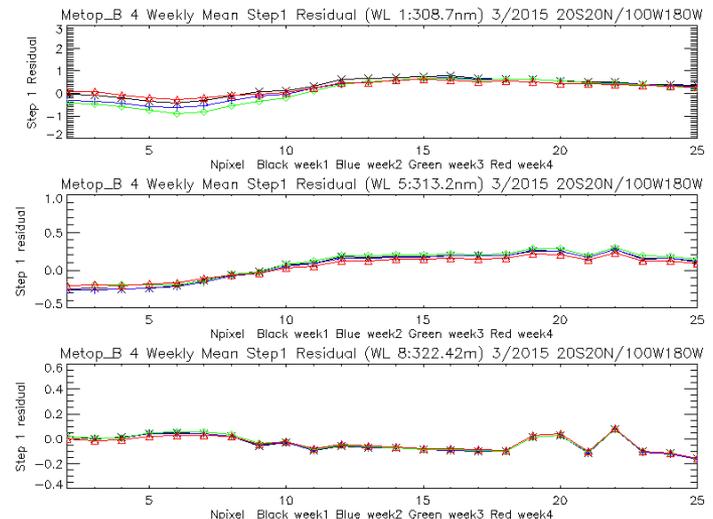
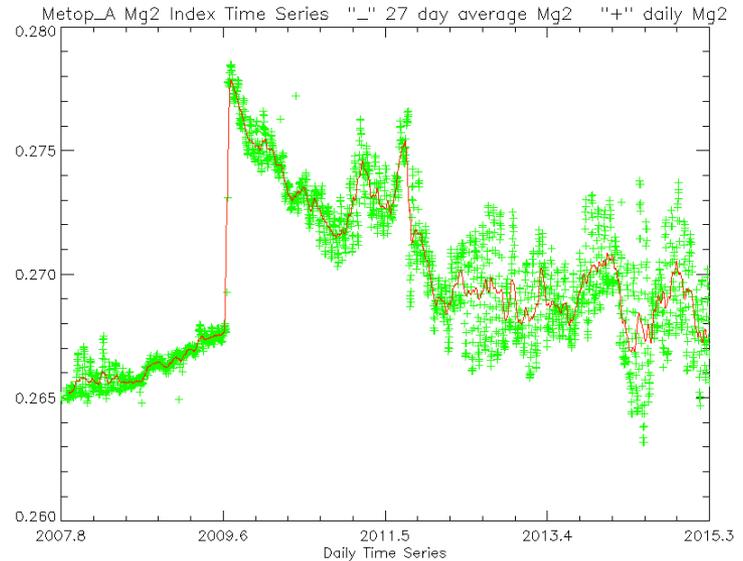
- SBUV/2 data products are monitored long term
- Parameters plotted include:
 - Daily zonal mean initial/final residual
 - Daily zonal mean initial/final residual standard deviation
 - Daily zonal mean total ozone pair difference
 - Monthly ozone retrieved A-priori profile difference
 - Weekly mean 1 percentile reflectivity



GOME-2 (Metop A+B)

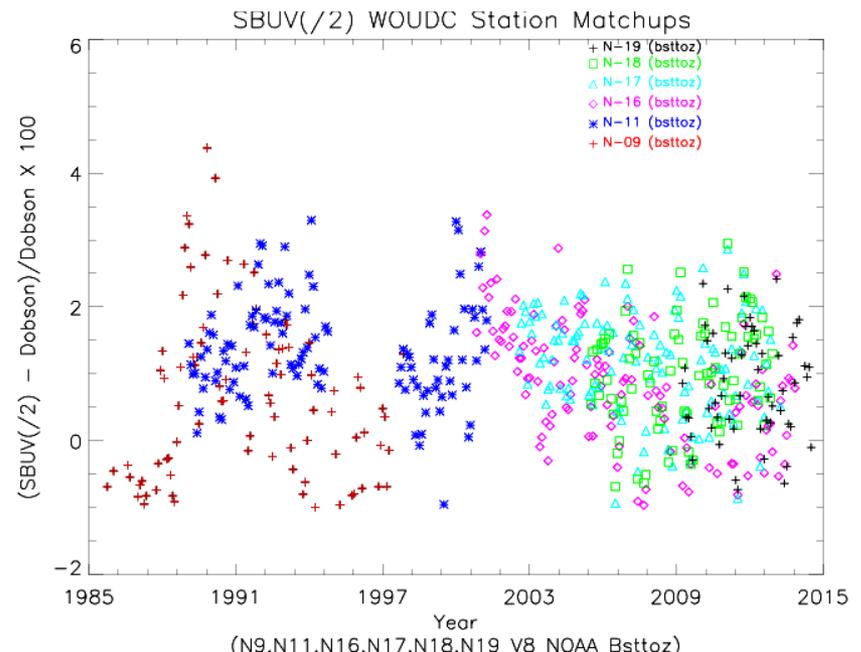
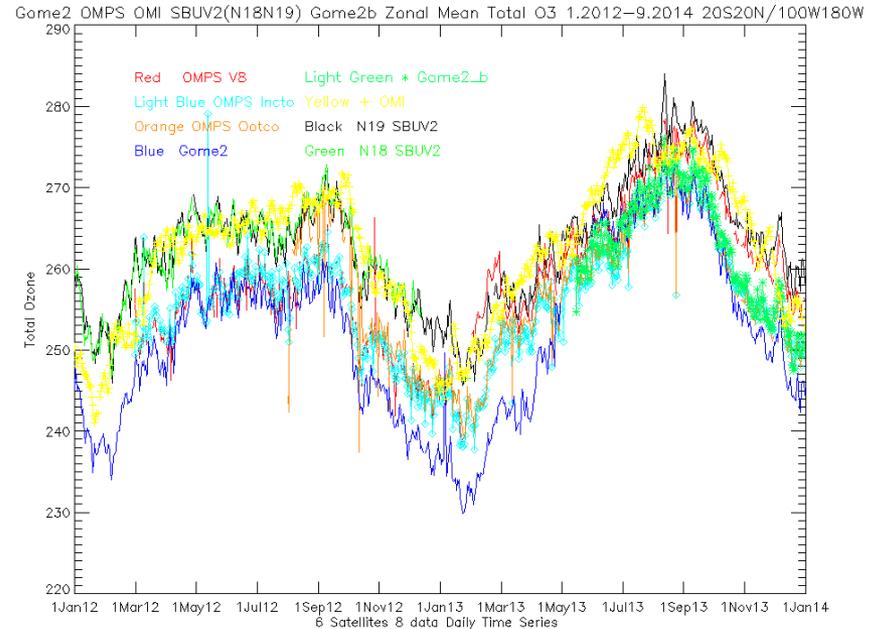
Parameters plotted include:

- Mg-II Index
- Daily zonal mean total ozone, aerosol index, reflectivity, step 1 residuals
- 4-Weekly mean total ozone, reflectivity, aerosol index, step 1 residuals



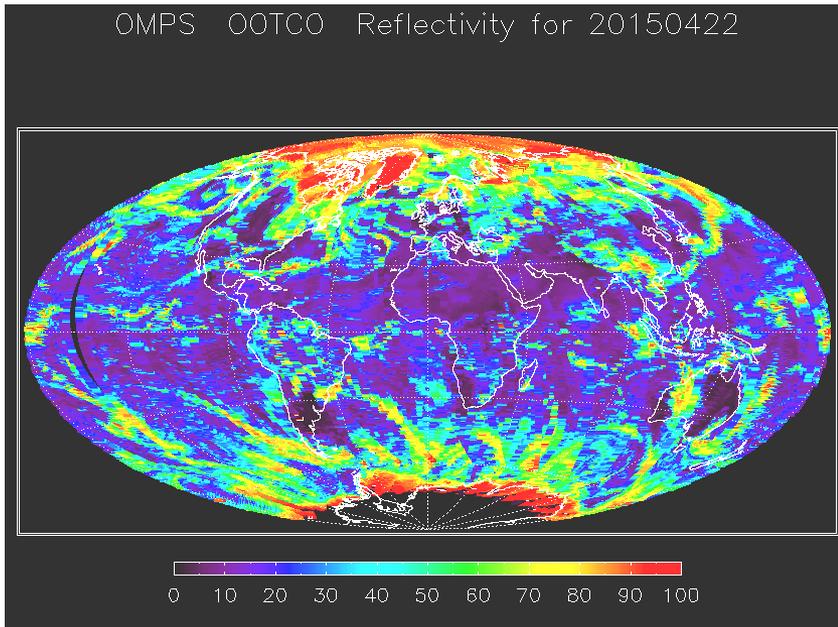
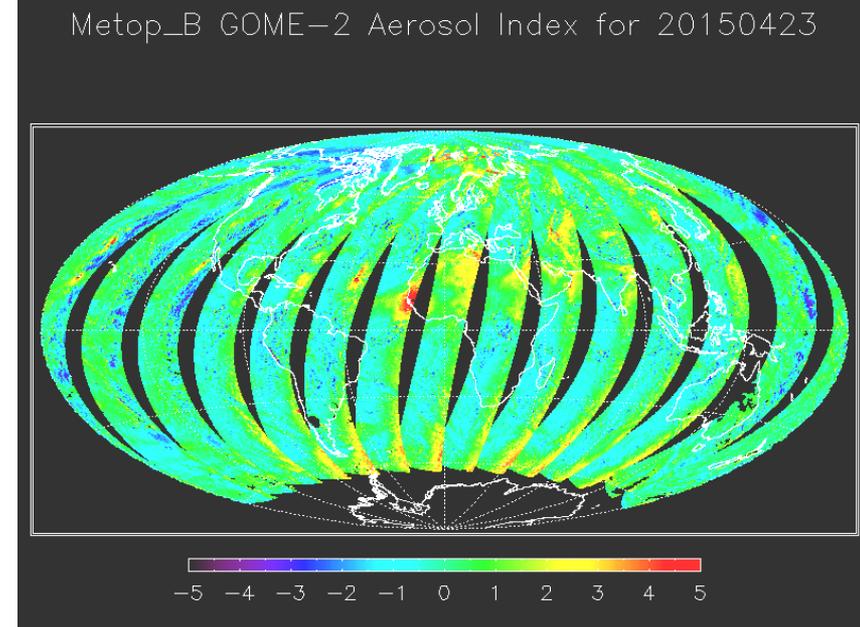
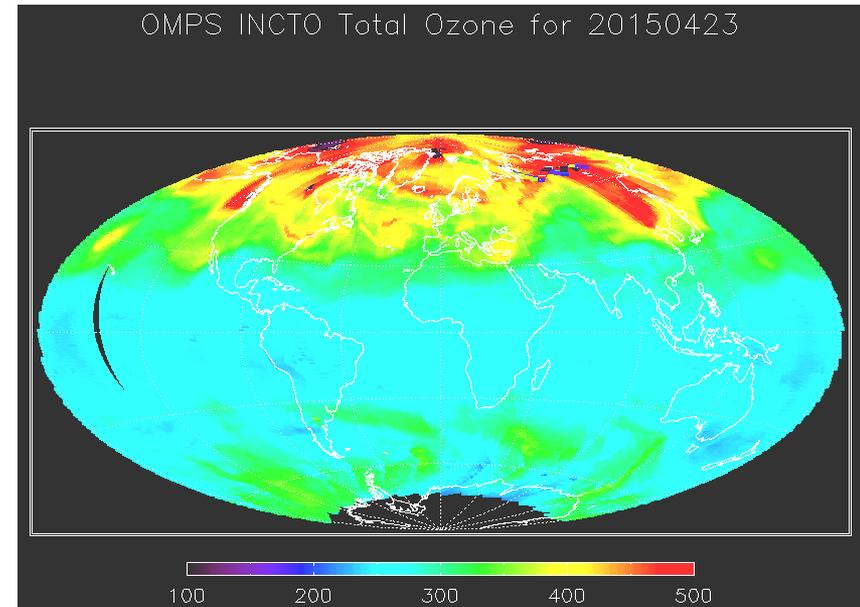
Ozone Product Comparisons

- Plots compare products from multiple ozone instruments
- Daily zonal mean comparisons
 - Chasing orbit comparisons
 - Comparisons with Dobson ground stations



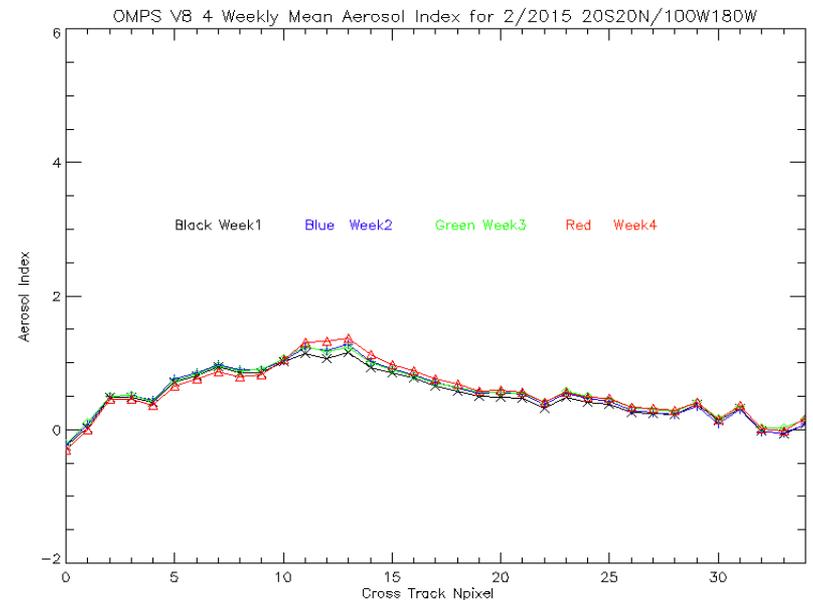
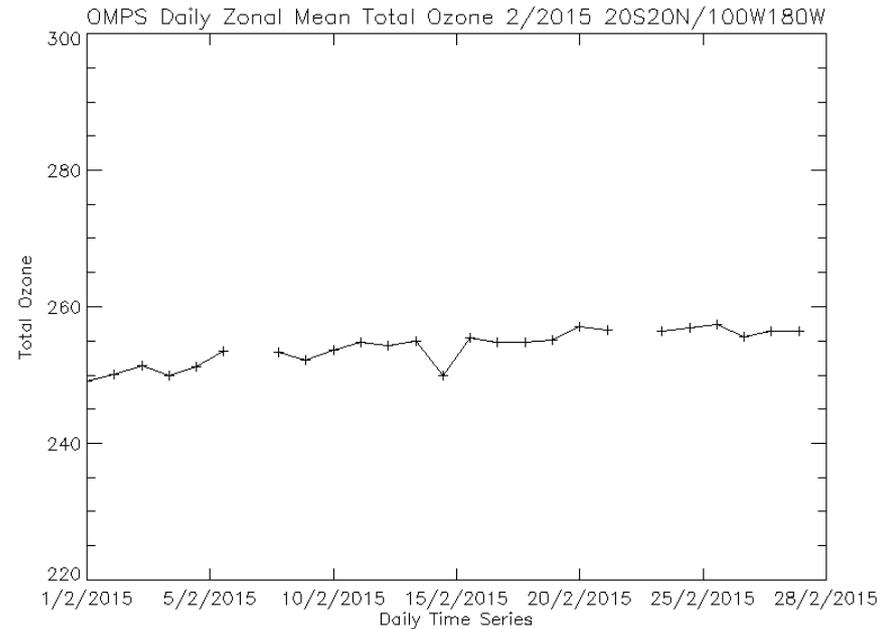
OMPS, GOME-2, and OMI Maps

- Daily “postage stamp” images depicting total ozone (right), reflectivity (below), and aerosol index (lower right)
- OMPS V8, INCTO, and OOTCO and GOME-2 V8 products are available



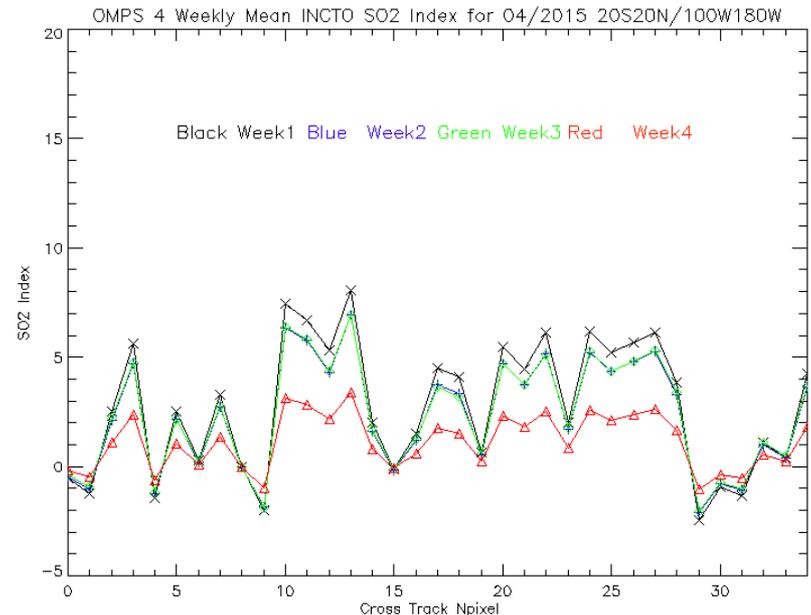
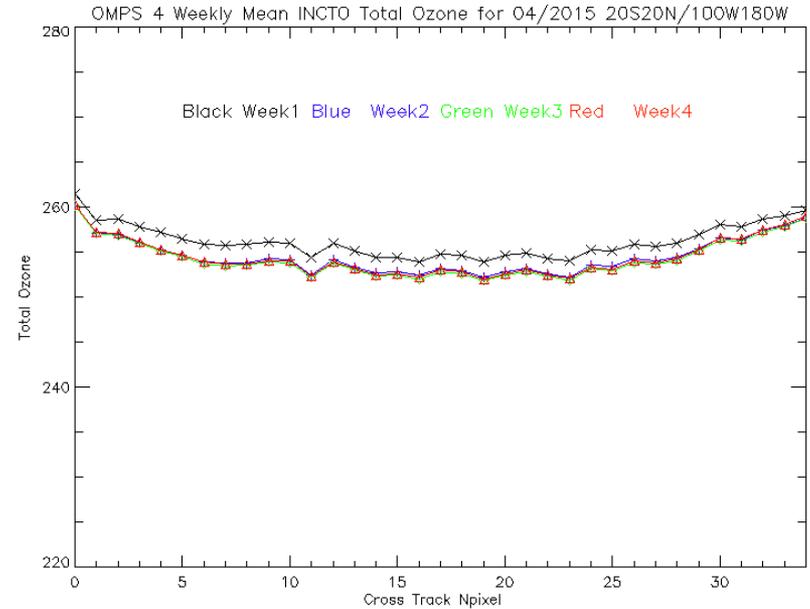
OMPS V8 Total Ozone

- Monitor the performance of the V8 ozone, reflectivity, and aerosol products
- Daily zonal mean and 4 weekly mean plots are available for each product



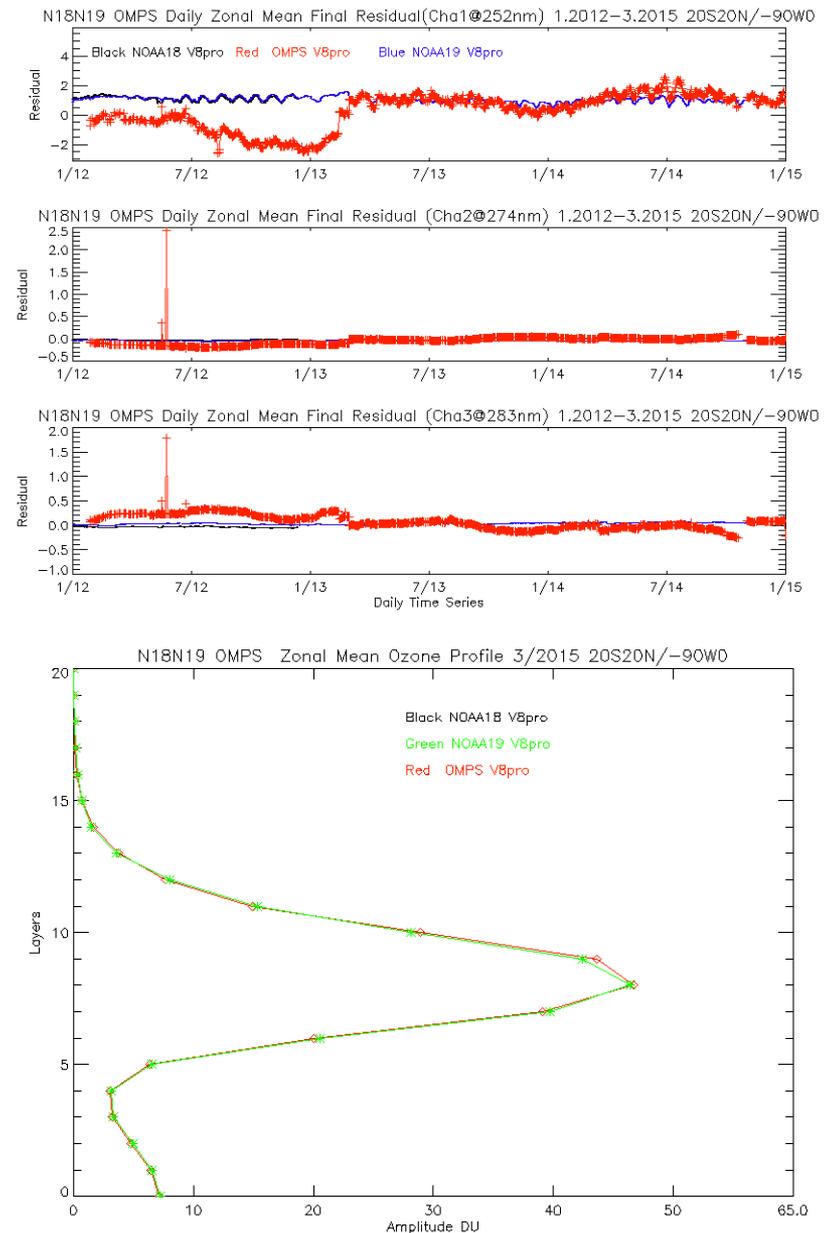
OMPS INCTO Product

- Monitor the performance of the operational INCTO product
- Graphs produced:
 - Daily zonal mean (Ozone, Aerosol, and SO₂ index)
 - 4-weekly mean and daily zonal 1 percentile plots are available for each product
 - Percent good rate
- Similar plots are made for the OOTCO product



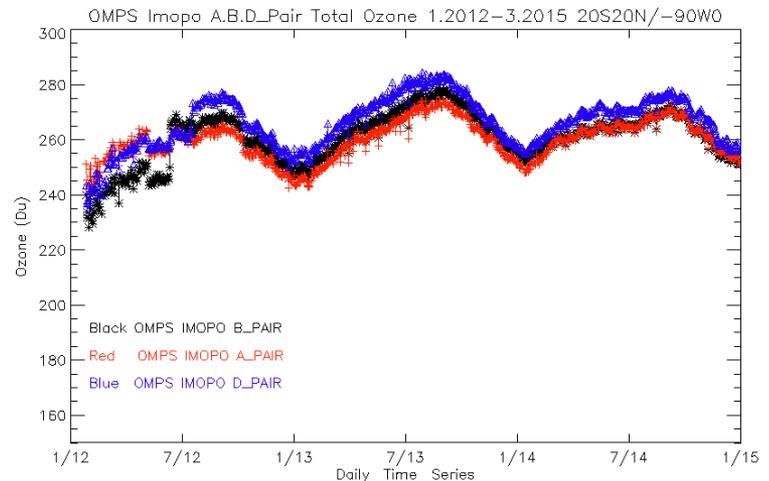
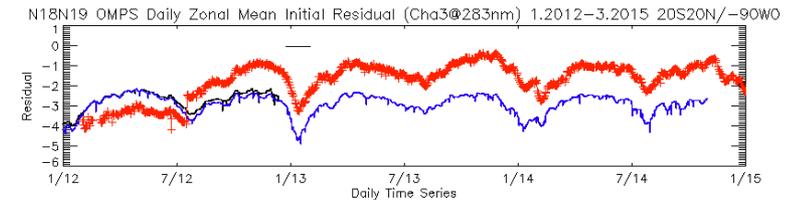
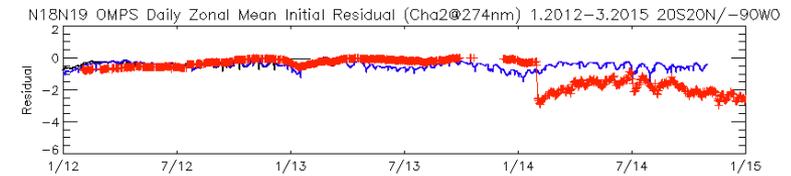
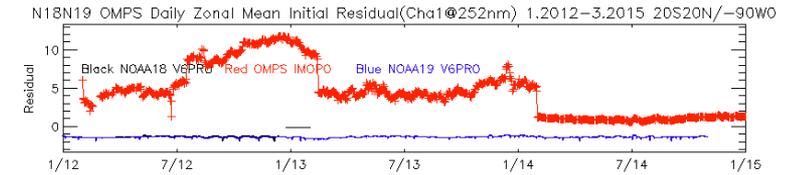
OMPS V8 Profile Product

- Monitor the performance of the V8 profile product
- Plots produced:
 - Daily zonal mean initial/final residual
 - Zonal mean total column O3 – profile O3
 - Retrieved – A priori plots are made



OMPS IMOPO Profile Product

- Monitor the performance of the operational IMOPO profile product
- Plots produced include:
 - Daily zonal mean initial/final residual, pair difference, and A,B,D pair total ozone
 - Column – profile
 - Retrieved – A priori
 - Percent good rate



Future Plans and Refinements

- Generate changes in distributions for darks.
- Generate monthly updates to trend plots for the Non-Linearity, even if they are boring.
- Identify key temperature sensor data for each instrument and track functions of them that are correlated with the wavelength scale variations -- orbital for the Nadir Mapper and annual for the nadir profiler. We can also track the wavelength scales provided in the SDRs.
- Review thresholds for the CCD Array Temperatures, Instrument Temperatures, Currents and Voltages.
- Update the Solar measurements and model components (Mg II, degradation, wavelength scale) -- Working every two weeks; Reference every six months. Also track the calibration factor Earth values once we start varying them over time.
- Provide links to data sets for bandpass, wavelength scale, Mg II scale factors, and measured and synthetic solar data sets. These will not change very frequently.
- Provide links to ground-based comparison sites and provide them with time OMPS products to display at their sites.